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Clayton GROUP SERVICES

TECHNICAL MEMORANDUM

To: Stan Komperda and Howard Chinn

From: Ron St. John

CC: Steve Faryan

Subject: **Pilot test work plan for Areas 1&2 to assess the implementation of full-scale biological treatment of the chlorinated solvents impacting the mass waste unit groundwater and the lower till.**

Date: May 20, 2004

Introduction

During the performance of groundwater investigations on the Lockformer project, Clayton Group Services, Inc. initiated the collection of general chemistry parameters that are indicative of microbiological processes effecting the reductive chlorination of the chlorinated solvents observed at the Lockformer site. This data has been previously reported to the regulatory agencies in reports issued by Clayton, however, all the groundwater general chemistry data collected to date has been tabulated and is provided as Attachment 1 to this memo. A review of the groundwater general chemistry data for the Lockformer site (Areas 1, 2 and 3, and offsite areas) offers the following general observations:

- Groundwater saturating the unconsolidated glacial sediments exhibits aerobic conditions (dissolved oxygen concentrations greater than 0.5 ppm and postive Eh values).
- Groundwater in the Silurian dolomite exhibits anaerobic conditions (dissolved oxygen concentrations less than 0.5 ppm and negative Eh values).
- Shallow groundwater in the unconsolidated glacial sediments in close proximity to sanitary sewer leaks exhibits elevated concentrations of nitrates (concentrations greater than 1 ppm).

In late August 2003, Clayton acquired and submitted soil and groundwater samples fr... the Lockformer site for bench-scale, microcosm testing to Dr. Robert Sanford an... Charlie Werth at the University of Illinois. The preliminary results of that test...g and recommendations to perform additional testing was the subject of a Decemb...r 8, 2003 memo. As a result of that memo, larger volume groundwater samples we... acquired and submitted for additional bench-scale testing on January 20, 2004. Larger volume groundwater microcosm tests were then undertaken. Recently, Professor's Sanford and Werth issued an interim evaluation report on the microcosm testing at the request of Clayton to help guide additional testing at the Lockformer site. This interim evaluation of the bench-scale microcosm testing was in letter report form and dated April 30, 2004, and is provided as Attachment 2 to this memo. Conclusions that can be drawn from this evaluation are as follows:

- Trace amounts of ethene were detected in one of the original small volume groundwater samples from the site that were incubated for 212 days, and where only lactate and format were added as electron donors. The importance of this finding is that, generally, it is observed that if the microorganisms that are responsible for complete reductive dechlorination are present in the groundwater system at one portion of the site they will be present in the groundwater systems across the site. The proper amount of electron donors and nutrients being available are likely to be the only limiting factor for complete biodegradation.
- Chitin appears to be a more favorable electron donor than lactate for dechlorination processes at the Lockformer site.
- Consistent with recent findings at other sites (He, J., et. al., 2003), it appears that vinyl chloride and ethene were only generated in significant amounts, during the short duration of the large volume microcosm study, where a culture known to reduce TCE to ethene was used as an inoculum.

To summarize, the results of the bench-scale testing indicate that the best bioremediation strategy may involve the use of chitin as an electron donor coupled with bioaugmentation of the groundwater system with an inoculum of anerobic bacteria capable of reducing TCE to ethene. As a result, the pilot test described by this memo has been planned to take advantage of these beneficial site-specific processes.

Biological Treatment Pilot Test in the Saturated Mass Waste Unit in Areas 1&2

A pilot test will be performed to determine the field-scale effectiveness of biological treatment of chlorinated solvents in groundwater of the mass waste unit in Areas 1&2 of the Lockformer site. The pilot test will be performed in the depression of the upper surface of the lower till in the vicinity of monitoring well MW-500D. This location offers the following advantages: 1) the depression around MW-500D is isolated, to some degree from the rest of the mass waste unit aquifer; 2) the groundwater within the depression exhibits elevated concentrations of site chlorinated constituents; and 3) a significant amount of TCE mass has already reductively dechlorinated to cis-1,2-DCE. If successful, the results of the pilot test will be used to design a full scale biological treatment system for the groundwater saturating the mass waste sediments above the lower till in Areas 1&2 of the Lockformer site.

Figure 1 depicts the area around the depression in the lower till in the vicinity of former monitoring well MW-500D, and the anticipated extent of the mass waste unit saturated conditions. As indicated in Figure 1, the pilot test will be performed using three withdrawal wells and one injection well. Both injection and withdrawal wells are proposed to allow for adequate mixing of the electron donor, and to best simulate a full-scale bioremediation system appropriate for Areas 1 and 2. The withdrawal wells will be located approximately 20 feet from the injection well at equidistant spacing around the injection well. Each of the wells will be constructed of 2-inch stainless steel with a 0.01 inch slotted well screen. It is anticipated that the injection well will be fitted with a 5-foot long well screen and the withdrawal wells will be fitted with 2-foot long well screens (subject to field conditions and findings). The base of each of the wells will be completed at the contact between the mass waste unit and the lower till. Figure 2 depicts the relationship between the injection well and each of the withdrawal wells.

A review of Figure 2 indicates that the injection well will be fitted with a chitin sock in the screen that will act as the desorption source for carbon and volatile fatty acids (VFAs) to the groundwater system. Groundwater will be pumped at each of the three withdrawal wells by bladder pumps utilizing compressed air. The bladder pumps in the withdrawal wells will be actuated by water level switches that control solenoid valves on the compressed air lines serving the bladder pumps. The withdrawal wells will discharge to an above ground 100-gallon, stainless steel, equalization tank through a discharge line fitted with a check valve to prevent backflow. The equalization tank will serve not only to mix the three withdrawal well streams, but will also serve to settle solids prior to re-injection, and to provide a location for sampling of, or amendment to the groundwater. The water in the 100-gallon stainless steel tank will gravity flow into the injection well via a one-inch stainless steel stinger pipe completed in the injection well below the static water level in the mass waste unit sediments. A high level water sensor will be placed in the equalization tank to shut down the compressor to the bladder pumps in case of clogging in the injection well.

All portions of the pilot test system have been designed to act as a closed system to avoid oxygenation interference. In addition, to the extent possible all system components will be constructed of stainless steel to prevent sample result interferences due to sorption. A variety of precautions will be taken to avoid oxygenation of the water stream. Some of these measures include: 1) controlling drawdown within the withdrawal wells to avoid aerating the well screen; 2) extending the injection stinger below the static water level of the aquifer to avoid aeration; and 3) the headspace in the injection well, the three withdrawal wells and the equalization tank will be filled with argon gas to avoid oxygenation of the water stream. Argon is relatively inert, is heavier than atmospheric air, and will serve to isolate the pilot test system water from contact with atmospheric air. The equalization tank, the injection well and each of the withdrawal wells will be fitted with pressure gauges, an argon gas injection nipple, and bleed valve. The equalization tank will be fitted with a sight window to monitor sedimentation in the tank, and a clean out access port in case of excessive sedimentation within the tank.

The pilot test will be conducted by pumping the withdrawal wells at their maximum rate given the water level actuator setting. The withdrawn groundwater will be sampled and amended in the equalization tank as needed, and the withdrawn water will be re-injected back to the aquifer via the gravity feed stinger pipe. Flow from the stinger pipe in the injection well will direct the water through a chitin sock installed in the injection well prior to it exiting the injection well screen back into the aquifer. In this way, organic carbon and VFAs will go into solution and be supplied to the aquifer. Injection of re-circulated aquifer groundwater will continue in this fashion until a stable anaerobic groundwater condition is created within the aquifer.

A complete suite of groundwater samples will be collected from each of the withdrawal wells and the injection well prior to test startup. The full list of monitoring parameters for the pilot test will include: 1) VOC analysis including ethene; 2) field measurements of ORP/Eh and dissolved oxygen; 3) general chemistry parameters including chloride, nitrate, sulfate, iron, manganese, and total organic carbon; and 4) VFAs. After startup, all samples will be obtained from flow through cell sampling ports fitted to the withdrawal well discharge lines. The samples for the general chemistry parameters and field measurements will be collected on a weekly basis. Samples for the determination of VOCs and VFAs will be acquired on a bi-weekly basis. The University of Illinois will analyze VOCs including ethene, and VFAs; and Severn Trent Laboratories will analyze general chemistry parameters.

The subsurface conditions will be monitored for an unspecified period of time to observe the nature of the anaerobic condition produced in the aquifer, the amount of carbon source available, the production of VFAs, and the degree of reductive dechlorination taking place. The nature of these conditions will dictate if the pilot test area will be inoculated. At some point in time during the pilot test, if it appears that sufficient progress is not being made through simple addition of the chitin to the groundwater system, an inoculum will be added. The inoculum will contain a mixture of anaerobic bacteria of known dechlorinating organisms capable of reducing TCE to ethene. The inoculum will be introduced through the injection port on the equalization tank.

At the initiation of the pilot test, a slug of sodium bromide of known volume and concentration will be introduced to the aquifer at the injection well to act as a tracer. This will be done to provide a measurement of the mass waste unit hydraulic characteristics and pore volume. The concentration and volume of the sodium bromide slug will be formulated to result in an overall concentration during operation of the pilot test of less than 500 mg/l.

At this time, it is difficult to tell how long it will take to complete the mass waste unit pilot test. However, based on the results of the bench-scale studies, it would appear to be likely that significant findings should be available within 6 months of startup. Mobilization for the mass waste unit pilot test will take place within 14 days of approval of this work plan.

Biological Treatment Pilot Test in the Lower Till in Areas 1&2

A pilot test will be undertaken in Area 2 of the Lockformer site within the lower till to determine the effectiveness of biological treatment for remediation of chlorinated solvent impacting the lower till. The pilot test will be performed at the location of soil boring SB-807, which has exhibited the highest concentration of TCE determined to be present in Area 2 of the site. Figure 3 illustrates the location of wells to be installed during the pilot test in the lower till of Area 2.

To perform the pilot test in the lower till, an injection well will be installed immediately adjacent to the location of soil boring SB-807. The construction of this injection well can be reviewed in Figure 4. The injection well will be constructed of 2-inch stainless steel with a 2-foot, slotted well screen. The bottom of the well will be completed three and one-half feet below the contact between the mass waste unit and the lower till. The soil samples acquired will be submitted for laboratory analysis of VOCs. A filter pack will be placed in the annular space to six inches below the contact, and a 2-foot bentonite plug will be set above the filter pack to seal the well screen, and lower till from the mass waste unit. The remainder of the annular space will be sealed with high-solids bentonite grout.

Immediately adjacent to, and on either side of the injection well, will be two monitoring wells located a distance of 5-feet from the injection well. One of these monitoring wells will be competed exactly like the injection well. The other monitoring well will be of similar construction to the injection well, but the top of its well screen will be completed 5-feet below the bottom of the injection well screen.

A chitin sock will be placed into, and extend to above the screen section of the injection well. A ½-inch water supply line will be installed through the sealed cap at the top of the injection well. A water supply line will provide water to the injection well from a sealed, 250-gallon field tank that has been nitrified to produce anaerobic conditions. The headspace in the field tank will be filled with argon to provide an anaerobic blanket. Each of the monitoring wells and the injection well will be sealed at the surface with an expandable cap, the headspace in the well will be filled with argon to promote anaerobic conditions. Water will be supplied to the injection well as needed to maintain a hydrostatic head in the well approximately five-feet above the lower till and mass waste unit contact. A water level actuator within the injection well will operate a solenoid valve in the water line to supply water to the injection well.

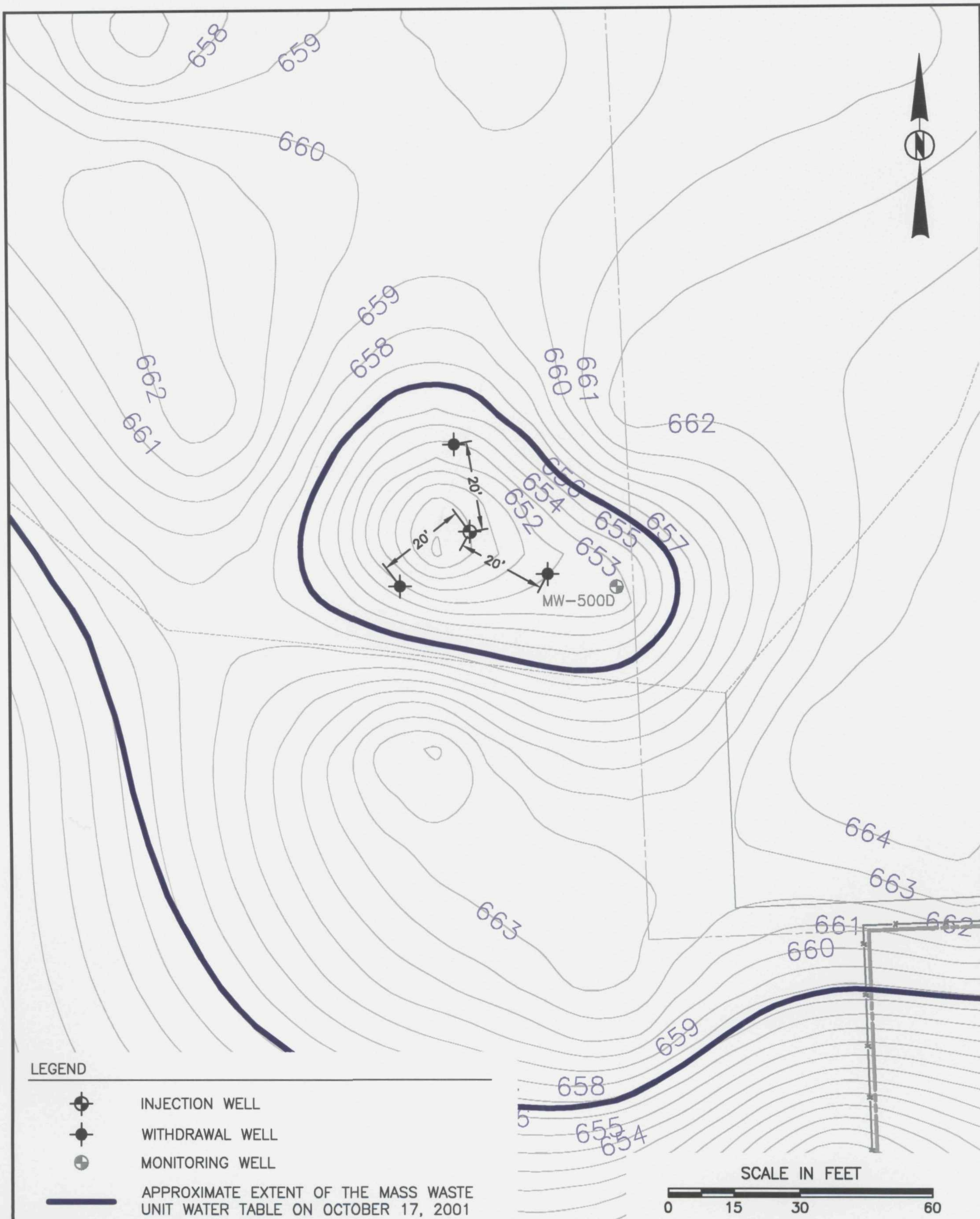
It is currently unknown whether the injection and monitoring wells will exhibit saturated conditions prior to the start of the pilot test. If either the injection well or the monitoring wells yield water sufficient for sampling, they will be sampled prior to the start of the pilot test for the following parameter analyses: 1) VOC analysis including ethene; 2) field measurements of ORP/Eh and dissolved oxygen; 3) general chemistry parameters including chloride, nitrate, sulfate, iron, manganese, and total organic carbon; and 4) VFAs. Since it is anticipated that the injection and monitoring wells completed in the lower till will exhibit very low yield, it will be necessary to sample them by bailer. If the monitoring wells initially do not exhibit saturated conditions, it is anticipated that the elevated hydraulic head imparted to the injection well will result in saturated conditions occurring in the monitoring wells at some time thereafter.

The monitoring wells will be sampled by two different methods. Due to concerns related to volatilization, sampling for VOCs will be performed through use of a sorbent trap in the monitoring wells that will be analyzed and replaced on a periodic basis (e.g., bi-weekly, depending on the results). General chemistry parameters and VFAs will be acquired for analysis by bailer. Due to the anticipated low yield of the lower till monitoring wells, and the use of bailers, it is likely that the dissolved oxygen and Eh values obtained from the lower till monitoring wells will not be accurate. As a result, the general chemistry parameters will be used as the primary indicator of transient groundwater conditions. The samples for the general chemistry parameters and field measurements will be collected on a weekly basis. Samples for the determination of VOCs and VFAs will be acquired on a bi-weekly basis. The University of Illinois will analyze VOCs, including ethene, and VFAs; and Severn Trent Laboratories will analyze general chemistry parameters.

The monitoring wells will be sampled for an unspecified period of time to observe the nature of the anaerobic conditions produced in the lower till, the amount of carbon source available, the production of VFAs, and the degree of reductive dechlorination taking place. The nature of these conditions will dictate if the pilot test area will be inoculated. The inoculum of anaerobic bacteria will contain known dechlorinating organisms capable of reducing TCE to ethene. At some point in time during the pilot test, if it appears that sufficient progress is not being made through simple addition of the chitin to the groundwater system, an inoculum will be added. The inoculum will contain a know mixture of anaerobic bacteria capable of reducing TCE to ethene. The inoculum will be introduced to the injection water of the field tank after ensuring that it exhibits the appropriate characteristics to sustain the inoculum.

The makeup water in the 250-gallon field tank used for injection will be mixed to contain a sodium bromide concentration of 450 mg/l. The sodium bromide will be used to determine the lower till hydraulic characteristics and pore volume.

At this time, it is difficult to tell how long it will take to complete the lower till pilot test. However, it would appear to be likely that significant findings should be available within 9 months of startup. Mobilization for the lower till pilot test will take place within 14 days of approval of this work plan.



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PILOT TEST INJECTION AND
WITHDRAWAL WELL LAYOUT

THE LOCKFORMER COMPANY
711 W. OGDEN AVENUE
LISLE, ILLINOIS

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FIGURE

1

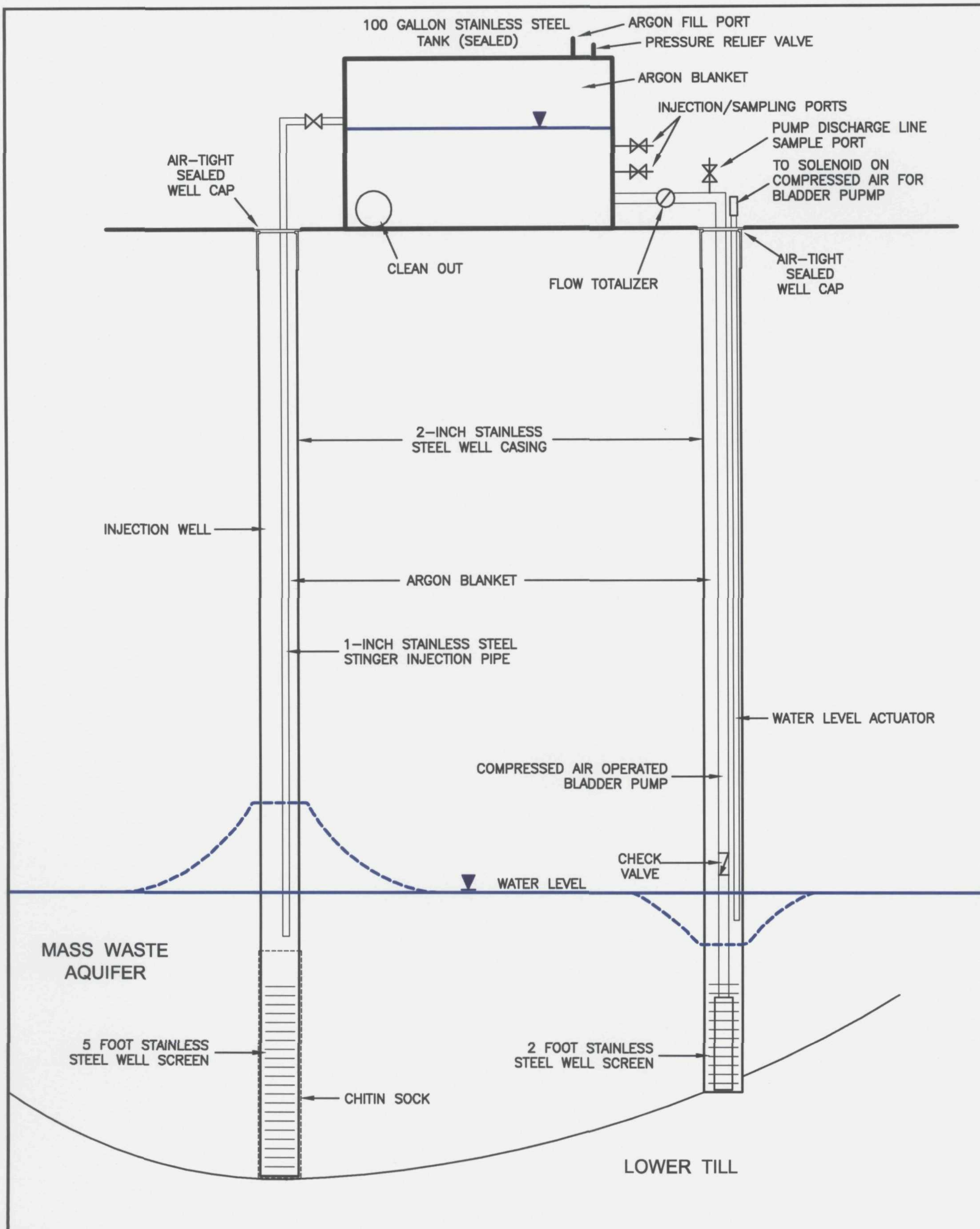

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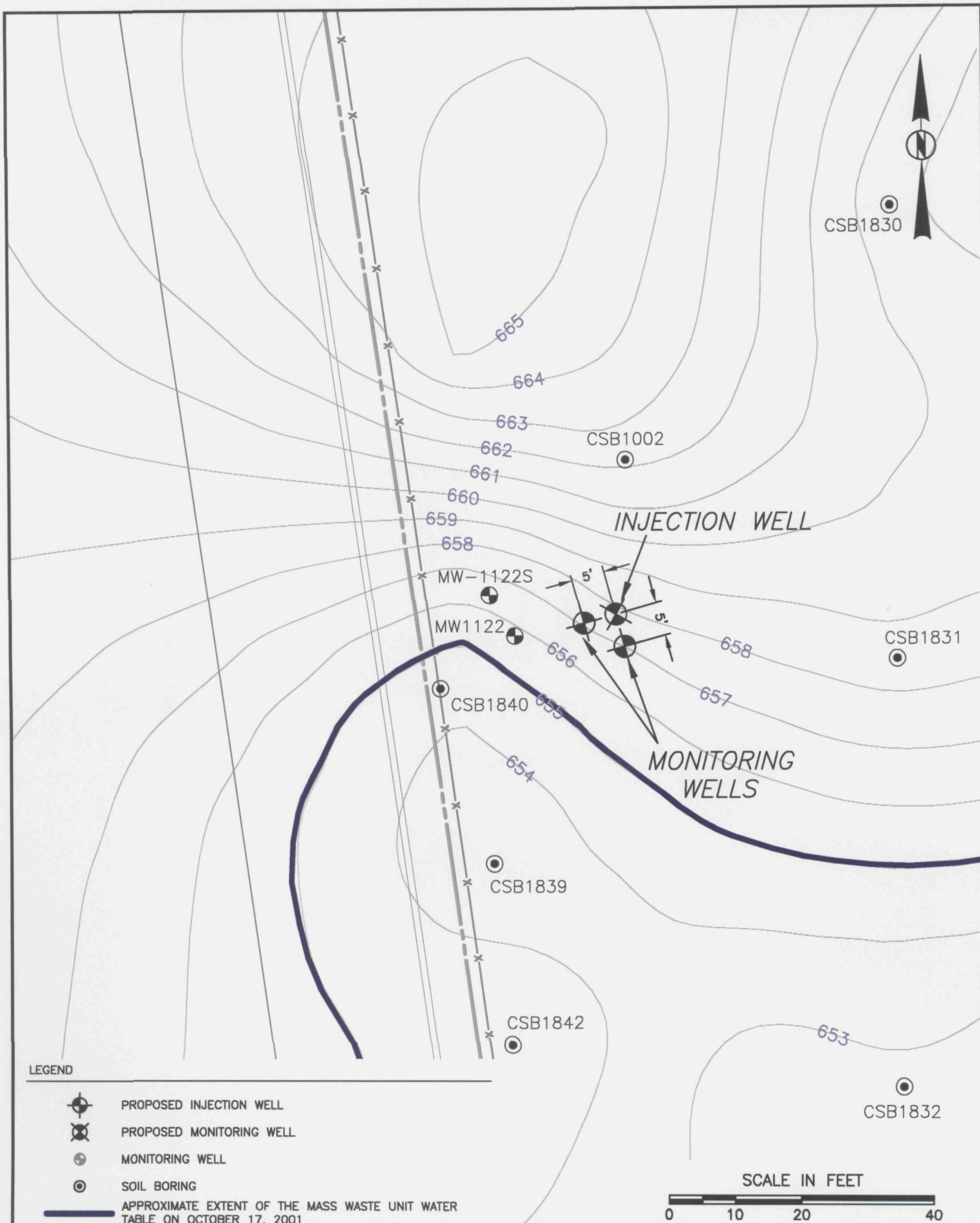
FIGURE 2



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LOWER TILL PILOT TEST INJECTION AND MONITORING WELL LAYOUT

THE LOCKFORMER COMPANY
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LISLE, ILLINOIS

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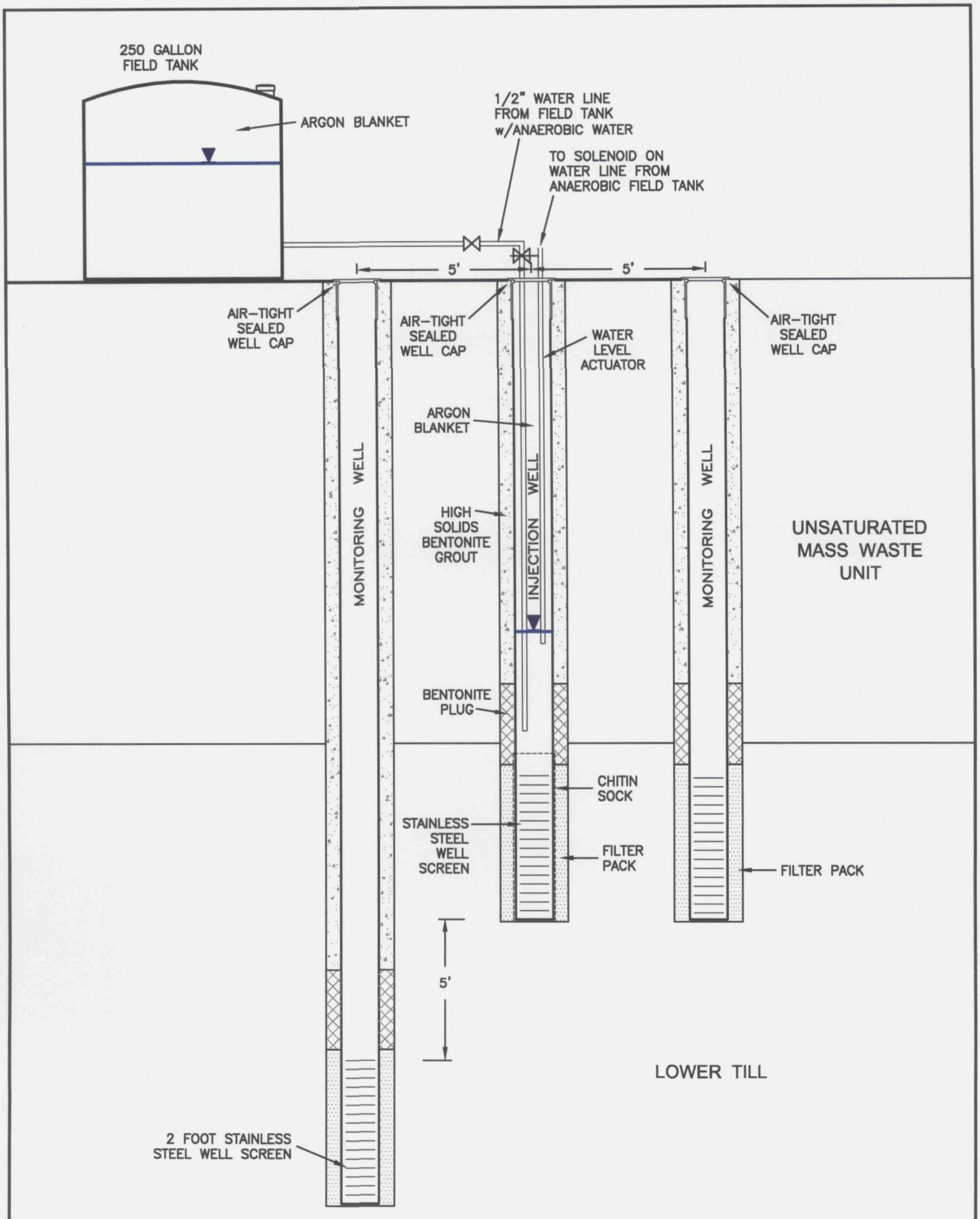
FIGURE 3



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LOWER TILL PILOT TEST SYSTEM
DEPICTING THE INJECTION WELL AND
MONITORING WELLS
THE LOCKFORMER COMPANY
711 W. OGDEN AVENUE
LISLE, ILLINOIS

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FIGURE 4

ATTACHMENT 1

Master General Chemistry Table

The Lockformer Company / Lisle, Illinois

PARAMETERS	BW1	BW2	BW3	MW101		MW120		MW123		MW126	
	8/5/02	8/2/02	8/1/02	6/21/01	8/27/02	6/21/01	8/16/02	6/20/01	8/19/02	6/15/01	8/9/02
Chloride	226	190	264	250	218	268	338	1,600	1,420	380	325
Chemical Oxygen Demand	<10	<10	10	26	37	15	16	<10	<10	<10	<10
Nitrate	0.15	0.13	0.39	<0.10	<0.10	<0.10	<0.10	0.64	<0.10	0.5	0.37
Sulfate	157	192	129	226	207	400	470	69	82	86	125
Sulfide	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Total Organic Carbon	6.8	6.5	6.4	3.07	12	4.32	4.6	1.66	7.8	1.2	7.8
Iron	0.15	0.02	<0.01	<0.01	0.21	<0.01	<0.01	0.14	0.13	0.09	0.28
Manganese	0.020	0.028	0.006	0.194	0.241	<0.001	0.068	0.101	0.296	0.009	0.065
Dissolved Oxygen	0	0	0	8.07	0	0.68	3.54	5.2		0	0
Oxygen Reduction Potential	-73	-104	13	81	-7	-22	99	14		-8	-66
Ethane	<0.020	<0.020	<0.020	<0.016	<0.020	<0.016	<0.020	<0.016	<0.020	<0.016	<0.020
Ethene	<0.020	<0.020	<0.020	<0.015	<0.020	<0.015	<0.020	<0.015	<0.020	<0.015	<0.020
BOD											

Master General Chemistry Table

The Lockformer Company / Lisle, Illinois

PARAMETERS	MW401		MW402		MW500D		MW501D		MW502S	MW502D
	6/15/01	8/14/02	6/19/01	8/20/02	6/21/01	8/26/02	6/19/01	8/19/02	6/14/01	8/14/02
Chloride	268	197	233	180	582	329	411	449	8	13
Chemical Oxygen Demand	<10	<10	<10	<10	<10	<10	<10	<10	25	<10
Nitrate	<0.10	<0.10	0.25	<0.10	<0.10	<0.10	0.88	<0.10	<0.10	<0.10
Sulfate	490	402	203	134	140	97	480	367	30	35
Sulfide	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Total Organic Carbon	1.4	2.1	1.19	3.1	2.01	7.0	1.06	13	4.6	4.1
Iron	0.24	0.42	0.02	0.51	0.42	0.43	0.02	0.95	0.06	2.36
Manganese	0.222	0.119	0.322	0.169	0.026	0.047	0.151	0.215	0.057	0.410
Dissolved Oxygen	1.41	1.49	0.88	1.71	0.91	0	4.87		4.44	0
Oxygen Reduction Potential	11	71	45	-6	-24	-18	71		111	-116
Ethane	<0.016	<0.020	<0.016	<0.020	<0.016	<0.020	<0.016	<0.020	<0.016	<0.020
Ethene	<0.015	<0.020	<0.015	<0.020	<0.015	<0.020	<0.015	<0.020	<0.015	<0.020
BOD										

Master General Chemistry Table

The Lockformer Company / Lisle, Illinois

PARAMETERS	MW504D		MW508D		MW513D		MW514D	MW515D		MW516D	
	6/13/01	8/14/02	6/12/01	8/14/02	6/12/01	8/13/02	6/14/01	6/14/01	8/16/02	6/20/01	8/21/02
Chloride	475	250	81	104	116	113	98	266	176	817	108
Chemical Oxygen Demand	12	<10	<10	<10	11	<10	<10	10	<10	<10	<10
Nitrate	1.32	0.62	2.25	1.77	<0.10	<0.10	<0.10	<0.10	<0.10	0.25	0.12
Sulfate	140	121	95	147	183	160	154	163	90	124	88
Sulfide	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Total Organic Carbon	2.2	5.8	1.8	11	1.2	7.3	1.2	1.2	4.7	1.64	6
Iron	1.38	1.11	0.01	0.18	<0.01	2.55	0.56	1.16	1.49	0.28	0.28
Manganese	0.226	0.032	0.202	0.032	0.024	0.031	0.039	0.148	0.101	0.032	0.028
Dissolved Oxygen	0.7	1.4	0.46	2.22	0.09	0	0	0	0	0.63	1.23
Oxygen Reduction Potential	19	-5	129	18	-64	-118	-42	-39	-64	4	6
Ethane	<0.016	<0.020	<0.016	<0.020	<0.016	<0.020	<0.016	<0.016	<0.020	<0.016	<0.020
Ethene	<0.015	<0.020	<0.015	<0.020	<0.015	<0.020	<0.015	<0.015	<0.020	<0.015	<0.020
BOD											

Master General Chemistry Table

The Lockformer Company / Lisle, Illinois

PARAMETERS	MW517D		MW521		MW522		MW1100S		MW1100D	MW1101S	
	6/19/01	8/21/02	6/18/01	8/20/02	6/18/01	8/26/02	6/11/01	8/8/02	9/9/02	6/11/01	8/9/02
Chloride	389	138	311	305	76	99	66	82	310	29	31
Chemical Oxygen Demand	<10	<10	<10	<10	<10	<10	12	<10	<10	10	<10
Nitrate	<0.10	<0.10	0.11	<0.10	0.14	<0.10	<0.10	<0.10	1.15	<0.10	<0.10
Sulfate	317	94	314	323	132	132	95	57	130	98	45
Sulfide	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Total Organic Carbon	1.16	3.4	1.3	5.5	1.6	7.1	1.2	16	6.3	1.3	23
Iron	0.81	1.96	0.03	<0.01	0.06	0.02	0.47	1.42	0.15	<0.01	1.44
Manganese	0.32	0.227	0.01	0.016	0.049	0.059	0.018	0.300	0.007	0.335	0.220
Dissolved Oxygen	0	0	1.06	0	0.83	0.8	1.12	0	0.68	0	0
Oxygen Reduction Potential	-29	-88	63	119	43	230	79	-75	-33	31	-73
Ethane	<0.016	<0.020	<0.016	<0.020	<0.016	<0.020	<0.016	<0.020	<0.020	<0.016	<0.020
Ethene	<0.015	<0.020	<0.015	<0.020	<0.015	<0.020	<0.015	<0.020	<0.020	<0.015	<0.020
BOD											

Master General Chemistry Table

The Lockformer Company / Lisle, Illinois

PARAMETERS	MW1101D			MW1102S	
	64.5-73.5 9/9/02	75-83 9/9/02	83-91 9/9/02	6/6/01	8/9/02
Chloride	303	298	280	188	111
Chemical Oxygen Demand	<10	<10	<10	<10	<10
Nitrate	0.66	1.23	0.63	<0.10	<0.10
Sulfate	134	131	148	163	105
Sulfide	<0.05	<0.05	<0.05	<0.05	<0.05
Total Organic Carbon	6.4	6.8	3.5	3.4	3.2
Iron	0.40	0.20	0.22	1.31	2.44
Manganese	0.008	0.009	0.020	0.215	0.137
Dissolved Oxygen	0.01	0.69	0.43	0	0
Oxygen Reduction Potential	-94	-30	-64	-63	-169
Ethane	<0.020	<0.020	<0.020	<0.016	<0.020
Ethene	<0.020	<0.020	<0.020	<0.015	<0.020
BOD					

Master General Chemistry Table

The Lockformer Company / Lisle, Illinois

PARAMETERS	MW1102D									MW1103S	
	73-81 9/4/02	83-91 9/4/02	91.5-99.5 9/3/02	97.5-105.5 9/3/02	105.5-113.5 8/29/02	113.5-121.5 8/29/02	123.5-131.5 8/29/02	132.5-140.5 8/28/02	142.5-150.5 8/28/02	6/6/01	8/12/02
Chloride	278	284	294	259	279	283	292	273	292	120	136
Chemical Oxygen Demand	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
Nitrate	0.25	0.27	0.40	0.24	0.35	0.31	0.33	0.27	0.28	0.1	0.17
Sulfate	111	139	113	130	113	109	112	104	97	124	100
Sulfide	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Total Organic Carbon	9.5	5.6	8.1	6.6	5.7	14	5.2	5.3	5.3	4.8	10
Iron	0.85	0.44	0.42	0.52	0.22	0.47	0.18	0.07	0.12	0.26	3.34
Manganese	0.015	0.012	0.031	0.017	0.011	0.046	0.012	0.014	0.018	0.201	0.126
Dissolved Oxygen	0	0.15	0.07	0.9	0	0	0	0	0	0	0
Oxygen Reduction Potential	-127	-100	-100	-108	-62	-91	-67	-39	-61	20	-92
Ethane	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.016	<0.020
Ethene	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.015	<0.020
BOD											

Master General Chemistry Table

The Lockformer Company / Lisle, Illinois

PARAMETERS	MW1103M		MW1103D								
	6/5/01	8/12/02	73.5-81.5 9/5/02	78.5-86.5 9/5/02	84-92 9/5/02	95-103 9/5/02	103-111 9/5/02	111-119 9/5/02	119-127 9/4/02	128.5-136.5 9/4/02	136.5-144.5 9/4/02
Chloride	494	447	280	289	283	235	236	229	273	265	249
Chemical Oxygen Demand	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
Nitrate	<0.10	<0.10	0.26	0.21	0.11	0.12	0.13	0.13	0.34	0.14	<0.10
Sulfate	198	179	136	132	136	169	170	167	118	118	136
Sulfide	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Total Organic Carbon	2.8	9.5	4.8	5.0	5.0	4.3	4.8	5.4	5.2	5.6	9.1
Iron	0.67	0.80	0.37	0.13	0.21	0.46	0.50	0.42	0.32	0.16	0.26
Manganese	0.162	0.082	0.008	0.008	0.020	0.026	0.028	0.026	0.016	0.020	0.019
Dissolved Oxygen	0	0	0	0.13	0.56	0.85	0.62	0.49	0.56	0.64	0.11
Oxygen Reduction Potential	-108	-115	-96	0.63	-74	-107	-102	-100	-67	-58	-81
Ethane	<0.016	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020
Ethene	<0.015	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020
BOD											

Master General Chemistry Table

The Lockformer Company / Lisle, Illinois

PARAMETERS	MW1104S		MW1104D			MW1105D			MW1107D		
	6/6/01	8/12/02	73.5-81.5 9/10/02	79.5-87.5 9/10/02	86.5-94.5 9/10/02	80-88 9/10/02	88-96 9/10/02	90-98 9/10/02	81-89 9/12/02	88-96 9/12/02	95-103 9/12/02
Chloride	103	131	280	282	280	286	277	281	320	332	347
Chemical Oxygen Demand	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
Nitrate	0.27	0.36	0.21	0.22	<0.10	0.22	0.17	0.17	1.02	1.02	0.96
Sulfate	96	103	106	98	103	125	159	161	116	117	118
Sulfide	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Total Organic Carbon	4.6	6.6	6.1	6.6	7.5	4.8	3.5	3.1	4.5	4.6	3.5
Iron	0.24	1.91	0.24	0.13	0.25	0.36	0.18	0.28	0.16	0.11	0.12
Manganese	0.144	0.178	0.005	0.005	0.026	0.013	0.028	0.028	0.004	0.003	0.007
Dissolved Oxygen	0.11	0	0	0.13	0	0.27	0.11	0.49	2.4	2.76	2.66
Oxygen Reduction Potential	38	-53	-85	-62	-91	-94	-76	-80	60	89	76
Ethane	<0.016	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020
Ethene	<0.015	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020
BOD											

Master General Chemistry Table

The Lockformer Company / Lisle, Illinois

PARAMETERS	MW1108S		MW1108D		MW1109		MW1110S		MW1110D	
	6/12/01	8/8/02	90-98 8/28/02	96.5-104.5 8/27/02	6/19/01	8/7/02	9/25/01	8/15/02	58-66 11/14/02	66-74 11/14/02
Chloride	289	164	274	280	156	142	98	31	253	234
Chemical Oxygen Demand	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
Nitrate	1.02	<0.10	1.91	2.00	0.87	0.74	<0.10	<0.10	<0.10	<0.10
Sulfate	156	209	91	91	126	102	75	75	127	97
Sulfide	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Total Organic Carbon	1.4	12	7.0	4.4	2.2	3.4	1.1	4.2	3.0	2.9
Iron	1.03	3.63	<0.01	0.01	0.06	0.55	0.67	1.33	0.12	0.12
Manganese	0.04	0.081	0.007	0.006	0.39	0.116	0.255	0.048	0.062	0.041
Dissolved Oxygen	0.61	0	1.78	1.68	0	0	0.36	0	0	0
Oxygen Reduction Potential	-27	-112	55	95	-29	-68	-104	-141	-69	-142
Ethane	<0.016	<0.020	<0.020	<0.020	<0.016	<0.020	<0.016	<0.020	<0.020	<0.020
Ethene	<0.015	<0.020	<0.020	<0.020	<0.015	<0.020	<0.015	<0.020	<0.020	<0.020
BOD										

Master General Chemistry Table

The Lockformer Company / Lisle, Illinois

PARAMETERS	MW1111S		MW1111D		MW1112S		MW1112D		MW1113S	
	9/25/01	8/15/02	57-65 11/14/02	65-73 11/14/02	9/25/01	8/15/02	56.1-64.1 11/15/02	65.6-73.6 11/15/02	9/26/01	8/6/02
Chloride	118	152	252	259	88	133	255	269	104	72
Chemical Oxygen Demand	<10	<10	<10	<10	<10	<10	<10	<10	<10	11
Nitrate	2.44	2.78	<0.10	<0.10	<0.10	0.17	0.11	0.10	0.16	<0.10
Sulfate	87	112	135	134	203	189	109	121	350	176
Sulfide	*<0.05*	*<0.05*	*<0.05*	*<0.05*	*<0.05*	*<0.05*	*<0.05*	*<0.05*	*<0.05*	*<0.05*
Total Organic Carbon	1	5.4	3.0	3.4	1.1	5.4	3.7	2.7	2.5	13
Iron	0.01	0.93	0.14	0.38	0.02	0.31	0.05	0.15	0.02	2.98
Manganese	0.047	0.025	0.146	0.130	0.224	0.182	0.002	0.008	0.471	0.252
Dissolved Oxygen	1.31	0.18	0.19	0	0	0	0	0	3.72	0.48
Oxygen Reduction Potential	87	-38	-40	-116	42	-42	-43	-64	75	-55
Ethane	<0.016	<0.020	<0.020	<0.020	<0.016	<0.020	<0.020	<0.020	<0.016	<0.020
Ethene	<0.015	<0.020	<0.020	<0.020	<0.015	<0.020	<0.020	<0.020	<0.015	<0.020
BOD										

Master General Chemistry Table

The Lockformer Company / Lisle, Illinois

PARAMETERS	MW1113M			MW1113D			MW1114S		MW1114D		
	9/26/01	Duplicate 4 9/26/01	8/6/02	64.5-72.5 8/27/02	74.5-82.5 8/27/02	80-88 8/26/02	9/26/01	8/7/02	74.3-82.3 9/11/02	78.3-86.3 9/11/02	86.3-94.3 9/11/02
Chloride	337	311	308	292	272	276	116	84	300	330	301
Chemical Oxygen Demand	<10	<10	<10	11	<10	<10	<10	<10	<10	<10	<10
Nitrate	0.25	0.28	0.81	0.55	0.15	0.15	<0.10	<0.10	0.67	0.83	0.63
Sulfate	106	104	117	84	90	100	135	156	96	100	92
Sulfide	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Total Organic Carbon	1.2	1.2	3.0	6.3	6.5	5.6	2.3	14	11	6.1	4.5
Iron	0.16	0.16	1.31	0.35	0.06	<0.01	0.04	0.97	0.10	0.10	0.35
Manganese	0.053	0.052	0.062	0.015	0.027	0.029	0.136	0.078	0.002	0.003	0.008
Dissolved Oxygen	0	0	0	0	0.1	0.89	0	0	0.03	0.11	0.47
Oxygen Reduction Potential	-37	-37	-125	-110	-35	-44	-87	-132	-36	-33	-70
Ethane	<0.016	<0.016	<0.020	<0.020	<0.020	<0.020	<0.016	<0.020	<0.020	<0.020	<0.020
Ethene	<0.015	<0.015	<0.020	<0.020	<0.020	<0.020	<0.015	<0.020	<0.020	<0.020	<0.020
BOD											

Master General Chemistry Table

The Lockformer Company / Lisle, Illinois

PARAMETERS	MW1115	MW1115S	MW1115M	MW1115D					MW1116	MW1116S	MW1116M
				59-67	67-75	75-83	87-95	95-103			
	11/27/01	7/29/02	7/30/02	8/14/02	8/13/02	8/8/02	8/7/02	8/7/02	11/27/01	7/31/02	7/31/02
Chloride	82	80	126.0	307	271	280	254	257	196	176	155
Chemical Oxygen Demand	<10	<10	<10	<10	<10	12	<10	<10	<10	<10	<10
Nitrate	1.49	3.33	2.34	0.72	0.52	0.68	0.58	0.52	1.51	1.42	0.72
Sulfate	169	172	178.0	118	125	129	144	143	106	80	120
Sulfide	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Total Organic Carbon	18	1.9	1.8	2.7	4.5	2.9	3.0	6.3	9	3.3	3.3
Iron	0.01	0.04	<0.01	0.47	0.41	0.43	0.42	0.05	0.04	0.02	<0.01
Manganese	0.282	0.009	0.006	0.013	0.027	0.033	0.039	0.048	0.062	0.004	0.012
Dissolved Oxygen	3.82	3.85	1.34	0	0	0	0	0	4.86	4.63	1.45
Oxygen Reduction Potential	204	207	204	-83	-57	-81	-97	26	123	228	125
Ethane	<0.016	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.016	<0.020	<0.020
Ethene	<0.015	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.015	<0.020	<0.020
BOD											

Master General Chemistry Table

The Lockformer Company / Lisle, Illinois

PARAMETERS	MW1116D						MW1117	MW1118	MW1119S
	57-65 8/26/02	65-73 8/21/02	73-81 8/21/02	81-89 8/20/02	89-97 8/20/02	97-105 8/20/02	11/1/02	11/1/02	7/1/03
Chloride	303	317	296	278	293	300	86	288	116
Chemical Oxygen Demand	<10	<10	<10	<10	<10	<10	<10	<10	<10
Nitrate	1.29	1.27	1.23	0.87	0.88	0.93	<0.10	0.72	0.69
Sulfate	106	111	107	138	122	122	136	112	112
Sulfide	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Total Organic Carbon	4.1	4.3	6.8	5.6	5.9	7.2	6.1	4.9	0.6
Iron	0.68	0.14	0.07	0.51	0.43	0.07	0.18	0.35	<0.01
Manganese	0.014	0.006	0.014	0.051	0.036	0.026	0.238	0.066	0.005
Dissolved Oxygen	0.66	0.55	0.46	0	0.27	1.15	0.81	0	
Oxygen Reduction Potential	-62	-21	66	-61	-55	12	-41	-66	
Ethane	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	
Ethene	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	
BOD									1

Master General Chemistry Table

The Lockformer Company / Lisle, Illinois

PARAMETERS	MW1119D						MW1120D				
	61-68 11/13/02	69-77 11/13/02	77-85 11/13/02	85-93 11/12/02	93-101 11/12/02	101-109 11/12/02	55-63 11/7/02	63-71 11/7/02	71-79 11/7/02	79-87 11/7/02	87-95 11/6/02
Chloride	292	270	243	211	237	254	268	227	212	222	216
Chemical Oxygen Demand	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
Nitrate	0.53	0.33	0.30	0.12	0.11	0.18	0.32	0.26	0.35	0.43	0.23
Sulfate	112	130	96	117	116	99	101	135	131	78	111
Sulfide	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Total Organic Carbon	3.2	3.7	15	16	2.0	1.6	4.3	6.3	4.8	4.8	7.3
Iron	0.30	2.19	2.45	1.46	0.75	0.38	0.29	0.67	0.70	0.18	0.31
Manganese	0.009	0.041	0.060	0.046	0.055	0.038	0.012	0.021	0.021	0.012	0.022
Dissolved Oxygen	0	0	0	0	0	0	0	0	0.02	0.21	0
Oxygen Reduction Potential	-78	-134	-139	-119	-111	-76	-79	-111	-97	-56	-85
Ethane	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020
Ethene	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020
BOD											

Master General Chemistry Table

The Lockformer Company / Lisle, Illinois

PARAMETERS	MW1121					MW1122	MW1123	MW1600S	MW1601S	MW1602S	
	61-69 11/12/02	69-77 11/11/02	77-85 11/11/02	85-93 11/11/02	93-101 11/11/02	1/30/03	1/30/03	11/26/01	11/27/01	11/26/01	Duplicate 6 11/26/01
Chloride	272	281	255	253	253	184	164	232	316	144	144
Chemical Oxygen Demand	<10	<10	<10	<10	<10	<10	<10	<10	13	<10	<10
Nitrate	0.53	0.70	0.58	0.55	0.53	<0.10	5.87	0.85	1.73	1.82	1.78
Sulfate	105	93	114	125	122	116	183	136	89	44	44
Sulfide	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Total Organic Carbon	3.7	4.8	4.4	3.5	4.0	5.9	9.2	9.8	16	5.1	7.6
Iron	1.20	0.69	0.34	0.87	0.89	0.06	0.25	0.08	<0.01	<0.01	<0.01
Manganese	0.041	0.023	0.011	0.023	0.032	0.110	0.083	0.027	0.05	0.002	0.002
Dissolved Oxygen	0	0	0.12	0.12	0.18	0.65	2.5	0	3.38	7.09	7.09
Oxygen Reduction Potential	-78	-96	-74	-80	-86	45	41	1	185	201	201
Ethane	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.016	<0.016	<0.016	<0.016
Ethene	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.015	<0.015	<0.015	<0.015
BOD											

Master General Chemistry Table

The Lockformer Company / Lisle, Illinois

PARAMETERS	MW1603 8/1/02	MW1604 8/2/02	MW1605 8/2/02	MW1915 6/30/03	MW1919 7/1/03	MW1923 6/30/03	MW2100S 7/30/03	MW2100M 7/30/02
Chloride	290	200	137	120	150	84	139	135
Chemical Oxygen Demand	<10	<10	<10	<10	<10	<10	<10	<10
Nitrate	1.22	1.02	<0.10	0.90	<0.10	<0.10	1.12	0.69
Sulfate	150	165	159	186	75	600	108	178
Sulfide	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Total Organic Carbon	6.8	12	6.3	1.4	2.8	2.0	2.0	4.6
Iron	<0.01	0.67	1.33	0.03	0.04	0.13	0.04	0.02
Manganese	0.149	0.029	0.044	0.033	0.129	0.211	0.004	0.034
Dissolved Oxygen	0.48	0	1.71				2.94	0.16
Oxygen Reduction Potential	-3	-78	-120				71	99
Ethane	<0.020	<0.020	<0.020				<0.020	<0.020
Ethene	<0.020	<0.020	<0.020				<0.020	<0.020
BOD				2	1	1		

Master General Chemistry Table

The Lockformer Company / Lisle, Illinois

PARAMETERS	MW2100D						MW2101	MW2102	MW2103	MW2129S	MW2130S	MW2131S
	57-65 8/19/02	65-73 8/16/02	73-81 8/15/02	81-89 8/15/02	89-97 8/15/02	97-105 8/15/02	10/31/02	10/31/02	10/31/02	7/1/03	7/1/03	7/1/03
Chloride	313	294	268	192	230	277	260	233	212	440	200	294
Chemical Oxygen Demand	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
Nitrate	1.19	1.09	1.02	0.54	0.78	1.25	0.56	1.11	0.98	<0.10	0.81	0.94
Sulfate	110	115	110	135	127	113	128	133	128	262	143	74
Sulfide	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Total Organic Carbon	4.3	4.5	5.3	3.8	4.8	4.0	4.0	5.8	4.8	0.5	0.8	0.6
Iron	0.78	0.32	0.21	0.27	0.28	0.11	0.61	0.71	0.51	0.09	0.09	<0.01
Manganese	0.013	0.011	0.011	0.015	0.019	0.005	0.057	0.041	0.046	0.200	0.233	0.024
Dissolved Oxygen	0.26	0.05	0.83	0.46	0.23	1	2.82	1.08	1.58			
Oxygen Reduction Potential	-75	-58	-51	-63	-64	22	-81	-27	-20			
Ethane	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020			
Ethene	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020			
BOD										1	2	2

Master General Chemistry Table

The Lockformer Company / Lisle, Illinois

PARAMETERS	MW2300S	MW2300M	MW2300D	MW2301S	MW2301M	MW2301D	MW2301D Dup-70	MW2306	RW-1	RW-2	RW-3	RW-11
	6/24/03	6/24/03	6/24/03	6/25/03	6/25/03	6/25/03	6/25/03	6/30/03	4/23/03	4/1/03	4/8/03	3/24/03
Chloride	639	321	287	607	606	356	367	740		NA	NA	NA
Chemical Oxygen Demand	10	11	<10	<10	<10	<10	<10	<10		NA	NA	NA
Nitrate	3.30	6.65	0.98	1.33	1.30	0.32	0.36	1.32	<0.10	0.95	0.16	0.44
Sulfate	76	80	109	88	88	120	119	70		NA	NA	NA
Sulfide	NA	NA	NA	<0.05	<0.05	<0.05	<0.05	<0.05		NA	NA	NA
Total Organic Carbon	0.7	0.8	0.7	1.0	1.1	0.8	1.0	0.59		NA	NA	NA
Iron	0.05	<0.01	<0.01	0.14	<0.01	0.11	0.11	0.02		NA	NA	NA
Manganese	0.124	0.146	0.001	0.020	0.036	0.032	0.031	0.009		NA	NA	NA
Dissolved Oxygen										NA	NA	NA
Oxygen Reduction Potential										NA	NA	NA
Ethane										NA	NA	NA
Ethene										NA	NA	NA
BOD	<1	<1	2	2	2	2	2	1				

Master General Chemistry Table Notes

The Lockformer Company / Lisle, Illinois

MW-1101D	=	Sample Location
64.5-73.5	=	Depth of sample in feet below top of casing (if applicable)
9/9/02	=	Sample Date

NA = Not Analyzed

Values expressed in milligrams per liter (mg/L), except Oxygen Reduction Potential, which is expressed in milliVolts.

ATTACHMENT 2

Evaluation of Anaerobic Dechlorination Activity in Sediment and Groundwater Samples from the Lockformer Site

Robert Sanford
Charles Werth
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Summary: Microcosms containing groundwater and sediment were run for up to 239 days to determine the extent of natural anaerobic dechlorination activity of TCE. Results indicate that microbial populations capable of dechlorinating TCE to c-DCE are present in several samples, but not all. It also appears that chitin may be preferred as an electron donor for dechlorination, at least for the groundwater microcosms. Vinyl chloride and ethene were detected in significant amounts only in microcosms inoculated with a mixed culture known to reduce TCE to ethene. This suggests that the best bioremediation strategy may involve both stimulation with a suitable electron donor and bioaugmentation with an inoculum of anaerobic bacteria capable of reducing TCE to ethene.

Objectives: Groundwater and sediment at the site are known to contain varying amounts of chlorinated solvents such as trichloroethene (TCE) as a result of previous industrial activity. To assess whether groundwater or sediment materials from the site contained appropriate microbial populations that could degrade anaerobically the TCE, microcosms containing different groundwater and sediment samples were started. Each microcosm was used to assess the conditions that were appropriate for stimulating reductive dechlorination of TCE. Ideally the final product of this biodegradation would be innocuous ethene.

Methodology: Three separate microcosm evaluations were conducted, one with sediment samples and two with groundwater samples. All microcosms were done in duplicate in 160 ml serum bottles incubated anaerobically. TCE (30-35 mg/L) was added to each bottle. Control microcosms were done in the absence of sample or without addition of electron donor.

Microcosm Set 1: Sediment samples (~ 20g) were added to each serum bottle. 100 ml of anaerobic medium with lactate (1mM) and formate (4 mM) as electron donors were added to each bottle.

Microcosm Set 2: Groundwater samples (~20 ml) were added in an anaerobic chamber to serum bottles containing 80 ml of anaerobic medium with lactate and formate as electron donors.

Microcosm Set 3: Groundwater samples (100 ml) were added from 1 liter sample bottles to 160 ml serum bottles. The larger water samples were purged with N_2 gas prior to transfer. Bottles were amended with limestone (~2 g) to provide buffering capacity to the groundwater. Three separate treatments were used: A) lactate as an electron donor, B) chitin (1 g) as an electron donor and C) chitin (1 g) plus an acclimated inoculum of dechlorinating organisms known to reduce TCE to ethene. Non-purified chitin was used because of our experience with it as an electron donor for dechlorination of chlorinated ethenes. The inoculum used was obtained from an environmental enrichment culture derived from natural river sediments and groundwater.

Results: The results of the microcosms are summarized in Tables 1-3 below.

Table 1: Dechlorination activity in sediment microcosms after 239 days of incubation.

Sediment Sample	Dechlorination Product	% Conversion
2136	c-DCE	79
2140	No Activity	
2141	No Activity	
2142	No Activity	

Table 2: Status of initial groundwater microcosms after 212 days of incubation

GroundwaterSample	Dechlorination Product (percent conversion from TCE)	Other Chemicals Observed[a]
MW101	c-DCE (>90%) t-DCE (<1 %) 1,1-DCE (<1 %) VC (<1 %) Ethene (<1 %)	1,1,1-TCA, TCE
MW516D	No Activity	TCE
MW1117	No Activity	TCE
MW113S	No Activity	TCE

[a]Includes the TCE added (27 μmoles) and products present in the groundwater sample.

Table 3: Status of TCE dechlorination in second groundwater microcosm set after 83 days of incubation. 27 to 30 μmoles TCE added to each microcosm.

Sample	Treatment	Dechlorination Product(s)	Percent conversion
MW1117	Control[a]	No Activity	
	Lactate	No Activity	
	Chitin	No Activity	
	Chitin + Inoculum[b]	c-DCE (13 μmoles) t-DCE (trace) 1,1-DCE (trace) VC (13.5 μmoles) ethene (trace)	~50 % < 1% <1 % ~ 50 % <1 %
MW516D	Control[a]	No Activity	
	Lactate	No Activity	
	Chitin	No Activity	
	Chitin + Inoculum	No Activity	
MW1115S	Control[a]	No Activity	
	Lactate	No Activity	
	Chitin	No Activity	
	Chitin + Inoculum	c-DCE (3.8 μmoles) t-DCE (trace) 1,1-DCE (trace)	13 % <1 % <1 %
MW1119S[d]	Control[a]	No Activity	
	Lactate	No Activity	
	Chitin[b]	c-DCE (16.8 μmoles) t-DCE (trace) 1,1-DCE (trace)	~50% <1 % <1 %
	Chitin + Inoculum[b,c]	c-DCE (5.6 μmoles) t-DCE (0.37 μmoles) 1,1-DCE (trace) VC (16.2 μmoles) ethene (0.8 μmoles)	19 % <1 % <1 % 54 % 3 %

[a] Control did not receive any electron donor.
[b] Only one replicate showed activity.
[c] Balance of chloroethenes present as TCE.
[d] Evidence of 1,1,1-trichloroethane (TCA) degradation in inoculated samples (65% removal).